

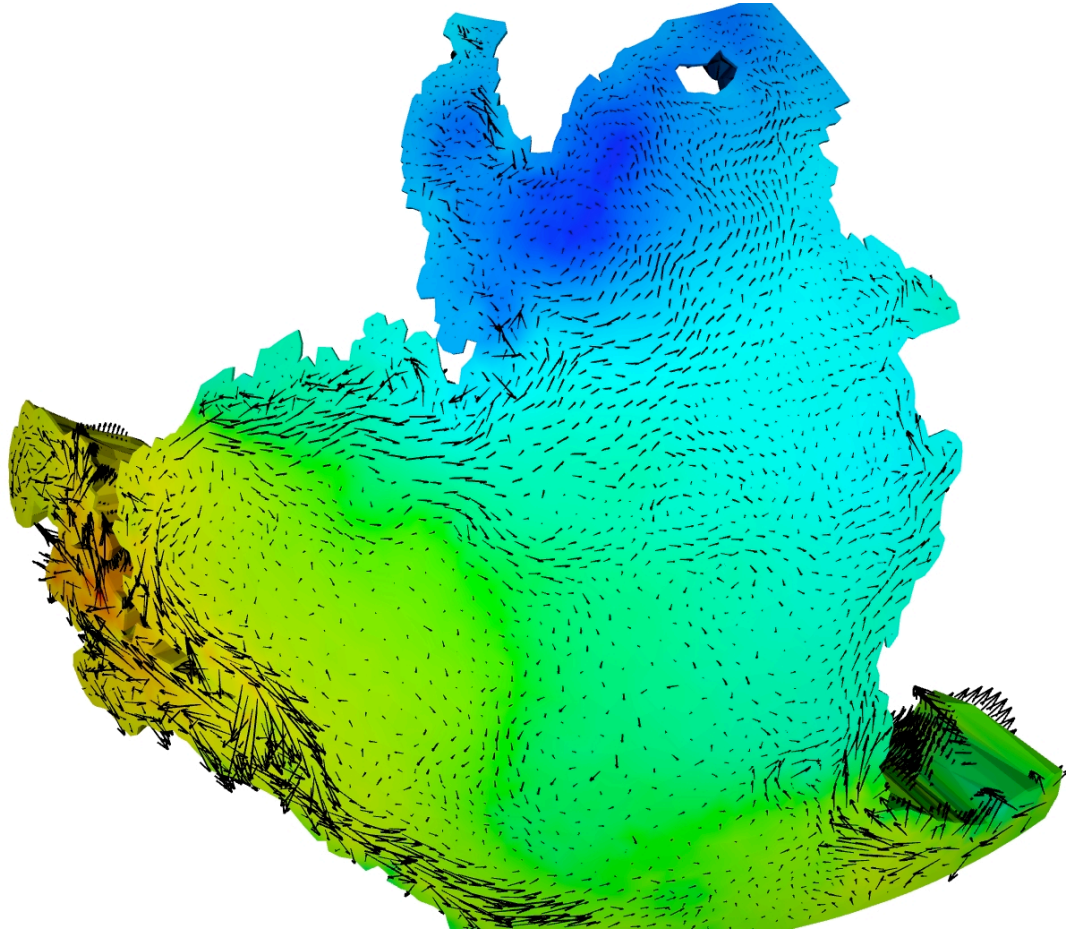
# Sub-Grid-Scale modelling for unstructured mesh ocean modelling

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# Outline of Talk

- Motivation
- Current methods
- What we want
- Our current SGS research

# Motivation: Large scale (global) and small scale modelling



# Current methods

- MY2.5 for vertical dissipation
- 2<sup>nd</sup> and 4<sup>th</sup> order Smag.
- MILES
- Stabilization of the free surface
- GM?

# What do we want?

- alpha model, but needs to be used with another turbulence model?
- GM for large scale flows with options for dissipation of momentum and tweaking
- Combined multi-equation models to form LES Stabilization that works in the horizontal and vertical and on all scales
- Linkage with mesh movement e.g. GM

## We want:

- Dissipation through discretisation methods e.g. DG, MILES, Petrov-Galerkin? - avoid double counting
- Linkage with mesh adaptivity and error measures may be through goals linking SGS errors and discretisation errors
- Higher order dissipation? – happens naturally with Adams approach and higher order elements

## We want:

- Control of element aspect ratio for resolved convection
- Spectral wave models for surface and internal waves – need to use RT models (future)?
- Incorporating SGS modelling of lots of physical processes

## Our current SGS research

- Jemma: SGS, at the moment GM, but covering 'physically based' SGS
- Adam: 4<sup>th</sup> order Smag. LES and other methods through discretisation
- David Ham: DG -SGS discretisation
- Colin: alpha model
- Chris and Matt: 2<sup>nd</sup> and 4<sup>th</sup> order LES
- Lucy: element aspect ratio control for convection



## Our current SGS research

- Yves and David Marshall: Mesh movement and eventual linkage with turbulence modelling e.g. flatten out density surfaces.
- Emmanuel and Jemma: Smag. with stratification then combined LES approach
- Patrick & Matt: Error measures – links with mesh adaptivity and therefore turbulence model – e.g. use goals to link SGS model errors with discretisation errors

# SGS road map to NA

- Stage 1: Getting the model to run
- Momentum: Fixed viscosity in the horizontal and in the vertical e.g.  $1\text{e}+3\text{m}^2/\text{s}$  in horizontal and  $10\text{m}^2/\text{s}$  vertical. Not sure if this should be in stress or tensor form.
- Temp etc: Fixed diffusivity in the vertical and horizontal - same values as momentum. Also high-resolution for advection. May be convective adjustment or MY.

# SGS road map to NA

- Stage 2: Basic formulation
- Momentum: LES (2nd and 4th order). Stress and tensor form?
- Temp etc: LES + high resolution + MY
- Stage 3: Advanced formulation
- Momentum: Alpha with 4th order LES.
- Temp etc: high resolution + GM + MY
- Stage 4: Contents of our research objectives.

# Conclusions

- Combined LES for vertical and horizontal and at all scales in the future
- Mesh movement and turbulence models
- Control of SGS model errors as well as discretisation errors through goals